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ABSTRACT

EncStat is a multimedia program under development that is designed to identify students with statistics anxiety or negative attitudes towards statistics. The purpose of this study was to develop a conceptual model of the current state of knowledge related to statistics anxiety intervention and to use that model to catalog and evaluate the small body of literature on which EncStat is based. The literature base was used to construct an initial conceptual model that included general categories of anxieties, theories, and models used as research foundations, empirical indicators, contextual factors, interventions, and outcomes. The overall number of coded elements in the concept map was examined by document, and the depth of coverage observed in the corpus of published literature was determined. The depth of coverage for each element of the conceptual map was reviewed. Findings show that a disproportionate number of documents focused on intervention, and a paucity of documents addressed theory and models. Findings also show the need to delineate additional categories of the conceptual model in some areas and the need to obtain more information on outcomes. An appendix lists the 32 literature sources reviewed. (SLD)

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Toward a Conceptual Model for Statistics Anxiety Intervention

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Toward a Conceptual Model for Statistics Anxiety Intervention

Background and Rationale

Fawcett (1986) defines a conceptual model as "...a set of abstract and general concepts and propositions that provides a distinctive frame of reference for the phenomena of interest to a discipline. It singles out certain things and rules them as relevant, and rules other things out due to their lesser importance. . . . [it] reflects the philosophical stance, cognitive orientation, and research tradition of a group of scholars, rather than the beliefs, values, thoughts, and research methods of all members of a discipline. Most disciplines have more than one conceptual model." (p. 83)

Whether explicit or tacit, these mutually agreed upon sets of concepts related to a phenomenon control the formation, development, and output of research communities. Besides their obvious utility as analytical tools, explicit conceptual models can speed the process of theory development and effective use of truths contained therein to improve the human condition. One such human condition that warrants attention to rapid improvement is statistics anxiety.

"No More Sadistics!"

Gal and Ginsburg (1994, p. 2) assert that "...students' feelings about statistics education, and the effects of these feelings on resulting learning, knowledge, and further interest in statistics, should occupy a more central role in the minds of statistics educators." As they note, many students employ the term 'sadistics', an unfortunately often true (at least from the student perspective) nickname appropriated from the student culture by B. Rosenthal in 1992: Rosenthal urged educators to "...acknowledge...the reality that unintended human suffering takes place under our watch."

Interest in statistics anxiety has increased recently, but most of that attention has focused on undergraduate statistics students and little has been done about intervention. Some researchers (Onwuegbuzie & Wilson, in press) estimate the percentage of graduate students who are uncomfortably anxious about statistics to be as high as between 66% and 80%. Success at statistics is essential for these students if they are to complete their doctoral programs, a realization that further exacerbates their anxiety.

The EncStat Program

EncStat is a multimedia program under development that is designed to identify students with statistics anxiety (SA) or negative attitudes towards statistics. Major elements of *EncStat* include identification of students with SA, amelioration of that anxiety using cognitive behavior therapy techniques, and assisting students to achieve more positive attitudes toward statistics, while providing

concept and skill support exercises. *EncStat* was developed when it was discovered that there was little literature and few structured programs available for students struggling with SA (a notable exception is a supplemental style statistics book -- *Statistics for the Terrifed* -- that includes a self-help chapter directly addressing alleviation of SA via rational emotive therapy). Initial foray into the educational and psychological literature revealed a substantial body of literature on math anxiety, with numerous and readily obtainable articles, books, and programs documenting consistent success in alleviating math anxiety, and, of course the various anxieties traditionally treated with psychotherapeutic techniques, the latter having been the target of psychological research for decades. An emerging body of literature on statistics anxiety was identified; however, few articles, each limited in scope, on treatment of statistics anxiety were found. Reasoning that techniques proven successful in alleviating math anxiety would meet with similar success in treating the anxiety component of SA, and assuming that there was a critical need to address the skills deficit issue, *EncStat-Student* was initially conceived of as having the following elements:

- Identification of students with SA and negative attitudes toward statistics
- Instruction about the nature of statistics anxiety (including emphasis that statistics is not as heavily mathematical as students typically believe)
- Instruction in relaxation techniques
- Cognitive restructuring
- Study Skills
- Concept/Skill Support

A related and essential part of alleviation of SA is instructor training. This second phase of EncStat (EncStat-Professor) is under development and includes instruction about the nature and effects of SA, encouraging classroom behaviors, and pedagogical issues idiosyncratic to successful instruction for the statistics anxious student, which help all students struggling to master statistics, not only those having anxiety.

Purpose

The purpose of this study was to develop a conceptual model of the current state of knowledge related to statistics anxiety intervention and to use that model to catalog and evaluate the small corpus of literature upon which *EncStat* is based.

Method

Initial Development of the Conceptual Model.

The literature base upon which *EncStat* was developed was used to construct an initial conceptual model having the "general form of a conceptual-theoretical-empirical structure" delineated by Fawcett (1986, p. 88). The model included general categories of anxieties, theories and models used as foundations for the research, empirical indicators, contextual factors, interventions and outcomes. Central in the conceptual model were the 10 subscales of the *Survey of Attitudes Towards Statistics Scale* (Schau, Dauphinee, & Del Vecchio, copyright pending) and the *Statistical Anxiety Rating Scale* (Cruise & Wilkins, 1980). A panel of experts reviewed the initial conceptual model and suggested areas in need of augmentation or other modifications. Subsequently, a coding protocol of the revised model's essential elements was constructed. The coding protocol (Figure 1) was then applied to the corpus of literature as a vehicle for content analysis. Such an analysis contributes to the evidence for validity of the model (by identifying concepts or relationships that may have been omitted or disregarded in the initial model development) and provides a map of the extant body of literature on statistics anxiety intervention (indicating the depth and breadth of the research base available on this phenomenon).

Sample

All documents surveyed during initial construction and subsequent refinement of *EncStat*, as described previously, were considered. Documents and books were initially identified in *Books in Print*, *World Catalog*, and educational and psychological data bases, including *ERIC* and *PsychLit*. Further search was conducted of bibliographies appearing in documents and books that had been retrieved.

Procedure

Abstracts of articles were carefully reviewed and documents addressing what were presumptively identified as key elements were retrieved and read. Those judged to be most relevant to the theoretical approach tentatively adopted for *EncStat* became the foundation for the concept model as well as the coding. A total of 32 documents (see Appendix A) was retrieved from the literature. Seven of these were papers presented at professional conferences, 15 were papers published in academic journals, and 10 were books.

Intercoder Agreement. To estimate the dependability of the measurement process used in this study, a sample of four sources was coded by two independent raters. The percentage agreement between the two raters was 82%, a level of reliability that is considered adequate for this initial investigation.

Results

The results of this research are presented in three sections. First, the overall number of coded elements in the concept map is examined by document. Second, the depth of coverage observed in this corpus of published literature for the major areas of the concept map is presented. Finally, the depth of coverage for each element of the map is reviewed.

Figure 1. *Coding Protocol for Conceptual Model*

Doc Type: 1=conference paper; 2=article; 3 = book
Extent of coverage: 1= little; 2=some; 3= comprehensively

Coder: ____ **Doc. ID No.** ____
Doc. Type ____

Anxieties										
Statistics		Math		Test		A7 State/Trait	A8 GAD	A9 HSP	A10 Social	A11 Other
A1 General	A2 State/Trait	A3 General	A4 State/Trait	A5 General	A6 State/Trait					

Theories and Models					
T1 Skills deficit	T2 Cog interference	T3 Anxiety/ expect	T4 Vgotsky	T5 Info Processing	T6 Other

Empirical Indicators						
STARS	E1 Worth	E2 Interp	E3 Test/class	E4 Computational	E5 Fear / help	E6 Fear / teacher
SATS	E7 Affect	E8 CogComp	E9 Value	E10 Difficulty		
Others	E11 Other					

Factors		
Dispositional	*Situational*	**Environmental**
F1 Self-esteem	F16 Math skill deficits /prior achieve.	F33 Gender
F2 Perceived scholastic competence	F17 No. & type math classes taken	F34 Race
F3 Perceived intellect ability	F18 Computer experience	F35 Math/statistics myths
F4 Perfectionism	F19 Programming experience	F36 Stereotypes
F5 Academic procrastination	F20 Satisfaction w/ stats course	F37 Size of class
F6 Hope	F21 Course status (elective or required)	F38 Physical char of classroom
F7 Multiple intelligences	F22 Course load	F39 Computer availability
F8 Stats preknowledge	F23 Personal problems	F40 Class length
F9 Exam taking strategies	F24 Family problems	F41 Class time of day
F10 Study skills & habits	F25 Time stress	F42 Instructor behaviors
F11 Expectations	F26 Emotional stress	F43 Delivery mode (live vs. web)
F12 Learn disabilities	F27 Group work	F44 Other
F13 Motivation	F28 Research projects	
F14 Locus of control	F29 Health	
F15 Other	F30 Point in program	
	F31 Past history with respect to math	
	F32 Other	

Figure 1 (Cont'd): *Coding Protocol for Conceptual Model*

Interventions		
Traditional	**Stat Specific (Instructor Behaviors)**	**Skill building**
I1 RET	I11 Positive attitude	I26 Support materials
I2 CBT	I12 Encouragement	I27 Examples of student work from previous
I3 Stress inoculation	I13 Recognition of anxiety	I28 Study skills
I4 System. desensitization	I14 Use of humor	I29 Other
I5 Breath retraining	I15 Individual help	
I6 Imaginal exposure	I16 Availability	
I7 Pleasant imagery	I17 Breaking material into small steps	
I8 Relaxation	I18 Use of activities to aid understanding	
I9 Drug Therapy	I19 Motivational activities	
I10 Other	I20 Opportunities to be successful	
	!21 Controlling negative conversants in class	
	I22 Discussion with peers	
	I23 Journal writing	
	I24 Math autobiography	
	I25 Other	

Outcomes				
O1 Achievement	O2 Understanding & use of research	O3 Attitudes	O4 Avoidance	O5 Other

Number of Elements Observed by Document

The distribution of the number of elements that were coded into the conceptual map for each of the 32 documents is presented in Figure 2. The number of coded elements ranged from a single element to 37 elements, with a median number of elements of 11.5, a mean of 11.75 elements and a mode of 14 elements. Thirteen of the documents (41%) evidenced fewer than ten coded elements, and only five of the documents (16%) provided more than 15 elements of the concept map.

Depth of Coverage for Major Areas

Table 1 provided the observed frequencies of coded elements for the six major areas of the concept map, with a breakdown of the depth of coverage observed (the marginal data from this table are presented graphically in Figure 3). The most frequently observed areas of the conceptual map were those of Interventions (with 147 occurrences, 39% of all the coded elements) and Moderating Factors (88 occurrences, 23% of the codings). Both Theories (10 occurrences, 3%) and Outcomes (14 occurrences, 4%) were rarely treated in this body of literature. An examination of the depth of coverage, however, suggests that the elements were comprehensively addressed when they occurred in the documents. Of the 376 codings of these documents, 256 represented comprehensive coverage (68%) and only 63 (17%) represented little coverage.

Table 1
Extent of Coverage of Major Areas of Conceptual Model

	Extent of Coverage			
Major Area	Little	Moderate	Comprehensive	Total
Anxieties	8	7	39	54
Theories and Models	1	2	7	10
Empirical Indicators	1	13	49	63
Moderating Factors	24	16	48	88
Interventions	27	15	105	147
Outcomes	2	4	8	14
Total	63	57	256	376

Figure 2. *Distribution of Number of Elements Coded Per Document*

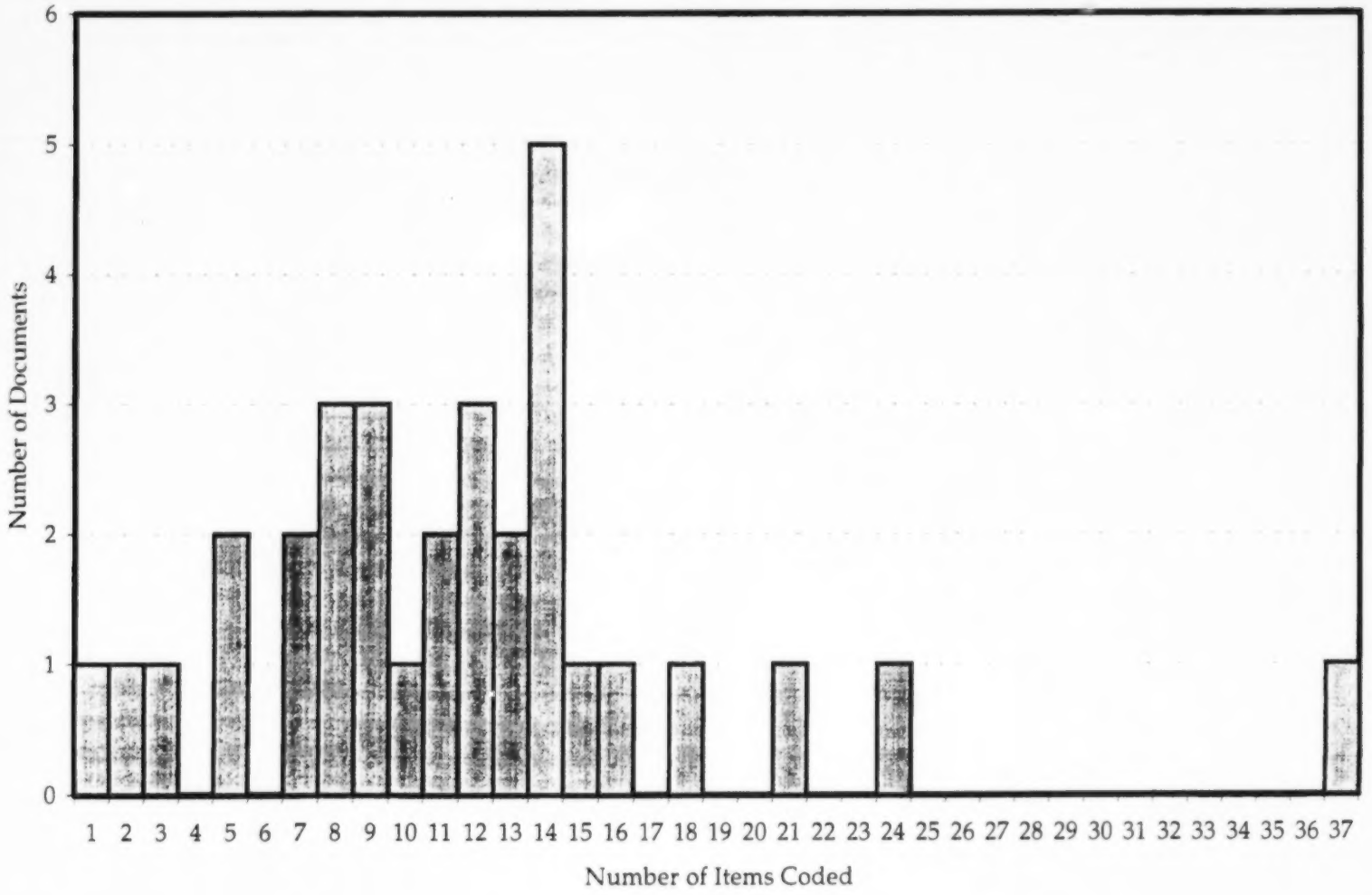
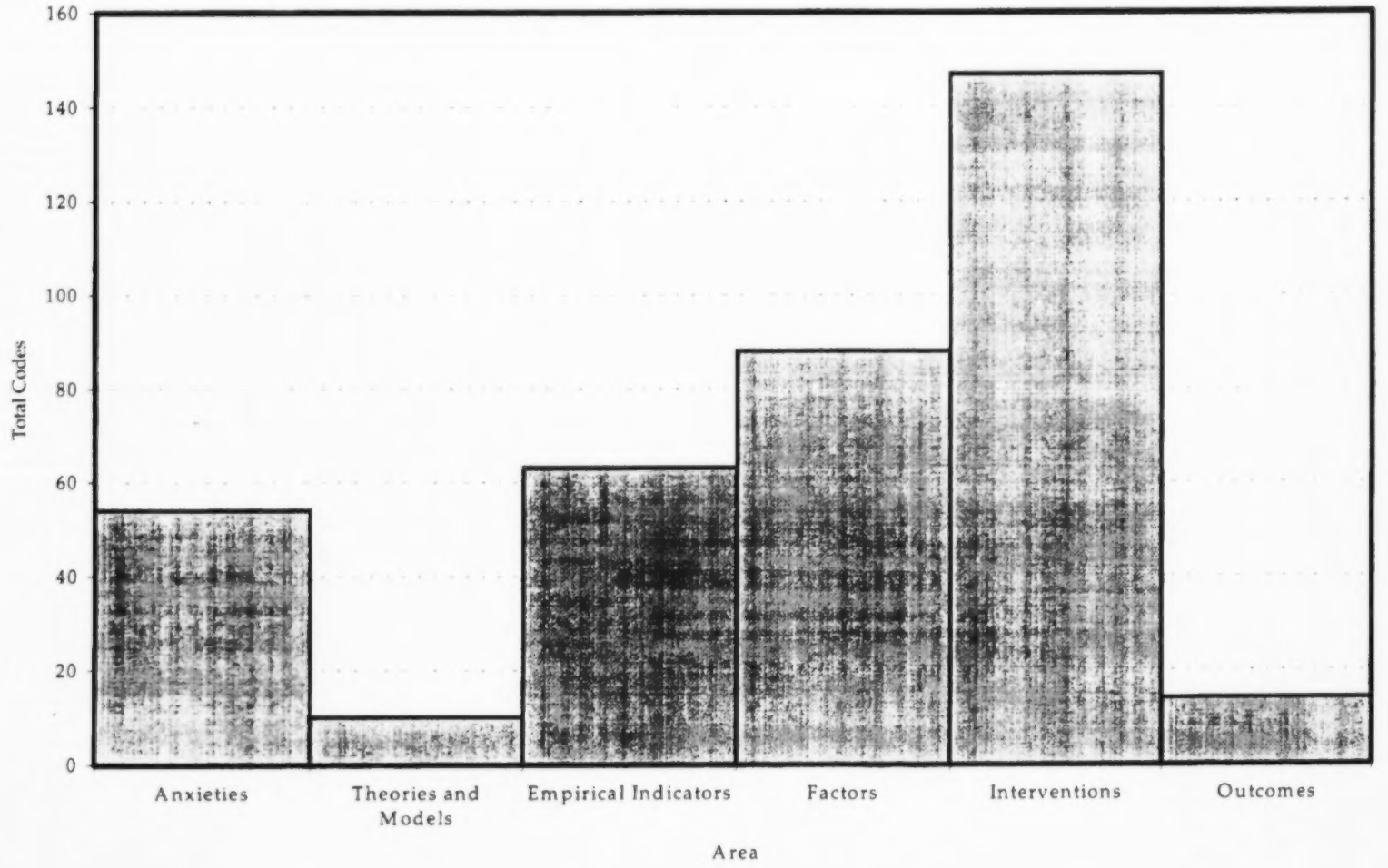


Figure 3. *Frequencies of Elements Coded By Major Area of Concept Map*



Depth of Coverage by Element

Anxieties. The observed coding frequencies and depth of coverage for the area of Anxieties are presented in Table 2. The most frequently observed type of anxiety was General Statistics Anxiety (n = 16, 50%), followed by General Math Anxiety (n = 10, 31%) and General Test Anxiety (n = 9, 28%). Although the treatment of general anxiety along the lines of State/Trait theory was relatively common (n = 6, 19%), the consideration of state/trait aspects of statistics anxiety, math anxiety or test anxiety was rare (only a single occurrence of state/trait aspects of statistics and math anxiety and only two occurrences of state/trait test anxiety. Similarly, the other elements of anxieties that were incorporated in the concepts map (e.g., Generalized Anxiety Disorder, Social Anxiety, Highly Sensitive Persons) were rarely treated in this body of literature.

Theories and Models. The observed coding frequencies and depth of coverage for the area of Theories and Models are presented in Table 3. This area of the concept map was rarely treated in the literature reviewed (receiving only 10 mentions in the 32 documents). Three theories and models received equally frequent treatment in these studies: Skills Deficit, Cognitive Interference and Information Processing (each receiving three mentions, 9%). The other Theory and Models elements of the concepts map were mentioned either a single time (Anxiety/Expectation) or not at all (Vygotsky).

Table 2
Extent of Coverage of Anxieties

	Extent of Coverage			
Element	Little	Moderate	Comprehensive	Total
Statistics: General	2	3	11	16
Statistics: State/Trait	0	0	1	1
Math: General	1	0	9	10
Math: State/Trait	0	0	1	1
Test: General	1	1	7	9
Test: State/Trait	1	0	1	2
State/Trait Anxiety	0	2	4	6
GAD	0	0	2	2
HSP	2	0	0	2
Social Anxiety	1	0	1	2
Other Anxiety	0	1	2	3

Table 3
Extent of Coverage of Theories and Models

Element	Extent of Coverage			Total
	Little	Moderate	Comprehensive	
Skills Deficit	0	1	2	3
Cognitive Interference	0	1	2	3
Anxiety/Expectation	0	0	1	1
Information Processing	1	0	2	3
Vygotsky	0	0	0	0

Empirical Indicators. Specific empirical indicators of anxiety were coded only 63 times for the 32 documents reviewed. The observed coding frequencies and depth of coverage are presented in Table 4. The elements corresponding to the *STARS* instrument were the most frequently observed in these documents (n = 8 or 9, 25% or 28%), with the *SATS* instrument's subscales being treated notably less often (n = 1 or 2, 3% or 6%). Further, the coverage of the *STARS* was typically rated as 'comprehensive' while that of the SATS was typically rated as 'moderate.' Finally, a large group of 'Other' empirical indices of anxiety were observed in the literature (n = 9, 28%).

Table 4
Extent of Coverage of Empirical Indicators

Element	Extent of Coverage			Total
	Little	Moderate	Comprehensive	
STARS				
Worth	0	2	7	9
Interpretation	0	1	7	8
Test/Class	0	1	7	8
Computational	0	1	7	8
Fear/Help	0	1	7	8
Fear/Teacher	0	1	7	8
SATS				
Affect	0	1	0	1
Cognitive Competence	0	1	0	1
Value	0	1	1	2
Difficulty	0	1	0	1
Other	1	2	6	9

Moderating Factors. Moderating factors associated with anxiety were coded 88 times for the 32 documents reviewed (Table 5). Among the dispositional factors, Study Skills, (n = 7, 22%), Perfectionism (n = 6, 19%), and 'Other' (n = 6, 19%) were the most frequently addressed. Among the situational factors, a set of three elements that represent students' histories with mathematics was the most frequently treated. Past History in Math (n = 7, 22%), Math Skills Deficits (n = 6, 19%), and Number of Previous Math Classes (n = 5, 16%) were the most commonly observed situational factors. Finally, among the environmental factors, only student gender was represented more than five times (n = 6, 19%).

Table 5
Extent of Coverage of Moderating Factors

Element	Extent of Coverage			Total
	Little	Moderate	Comprehensive	
Dispositional				
Self-Esteem	2	0	0	2
Scholastic Competence	1	0	1	2
Intellectual Ability	2	0	1	3
Perfectionism	1	2	3	6
Procrastination	0	1	2	3
Hope	0	0	1	1
Multiple Intelligences	0	0	2	2
Testing Strategies	0	0	2	2
Study Skills	0	2	5	7
Expectations	1	1	1	3
Locus of Control	0	0	1	1
Other	2	0	4	6
Situational				
Math Skills Deficits	1	1	4	6
Previous Math Classes	2	2	1	5
Satisfaction with Stat Class	1	0	0	1
Course Status (elective?)	0	1	0	1
Time Stress	0	0	1	1
Group Work	1	0	1	2
Past History in Math	1	2	4	7
Other	1	0	3	4
Environmental				
Gender	3	1	2	6
Race	1	1	1	3
Myths	1	1	2	4
Stereotypes	0	0	2	2
Classroom Physical Characteristics	1	0	0	1
Class Time of Day	2	0	0	2
Instructor Behaviors	0	0	1	1
Other	0	1	3	4

Interventions. The area of interventions for anxiety was the most frequently observed area of the concept map, coded 147 times for the 32 documents reviewed. The observed coding frequencies and depth of coverage are presented in Table 6. Among the traditional treatments of anxiety, Relaxation (n = 9, 28%), Desensitization (n = 7, 22%), Breath Retraining (n = 7, 22%) and Positive Imagery (n = 7, 22%) were the most frequently observed. For instructor behaviors specifically directed towards the reduction of statistics anxiety, the development of a positive attitude was most frequently explicated in the documents (n = 10, 31%), followed by encouragement, use of humor, and journal writing (each with n = 8, 25%). Finally, for the skill building interventions, the development of study skills (n = 8, 25%) was observed notably more frequently than either support materials (n = 3, 9%) or other skill building (n = 2, 6%), and the use of samples of previous students' work was not addressed in the documents.

Outcomes. The explicit treatment of student outcomes was rarely observed in this corpus of literature, being coded only 14 times for the 32 documents reviewed. The observed coding frequencies and depth of coverage are presented in Table 7. The most frequently addressed outcome was student attitudes (n = 5, 16%). Indices of student achievement in statistics and the understanding and subsequent use of statistics and research were each observed in three documents (9%). Finally, student avoidance was treated as an outcome in two of the documents (6%).

Discussion

In considering results obtained, it is essential to bear in mind the boundaries imposed by the purposes for this paper. Effort was focused on gathering information about the state of the art regarding scholarly work on statistics anxiety and cataloging the small body of literature upon which *EncStat* is based. Our purpose was not to critique the quality of the research base nor was it to construct a comprehensive synthesis. Although such a review of research will be a worthy undertaking, it stands as the focus of future research efforts subsequent to this initial reconnoitering of the scholarly landscape.

Given the purpose of this paper, the finding that a disproportionate number of documents focused on intervention and that a paucity of documents addressed theory and models is not entirely surprising. An expansion of the range of literature included will likely remedy this imbalance. Future work will also include an in-depth survey of what is known about teaching strategies that has particular application to pedagogy for SA students. Additionally, the finding of numerous instances of 'Other' categorizations (i.e., three in anxieties, nine in empirical indicators, 14 in moderating factors, 21 in interventions, and 1 in outcomes) indicates the need to delineate additional categories of the conceptual model in these areas. Finally, analysis of results revealed the need to obtain more information on outcomes. Should an

inadequate amount of information on these areas be identified, those points of interest will be added to the EncStat research program.

Table 6
Extent of Coverage of Interventions

Element	Extent of Coverage			Total
	Little	Moderate	Comprehensive	
Traditional				
RET	0	1	2	3
CBT	0	1	3	4
Stress Inoculation	1	0	3	4
Desensitization	2	1	4	7
Breath Retraining	0	1	6	7
Imaginal Exposure	0	1	1	2
Imagery	1	0	6	7
Relaxation	3	1	5	9
Drug Therapy	0	0	1	1
Other	2	1	7	10
Statistics Specific				
Positive Attitude	1	1	8	10
Encouragement	2	0	6	8
Recognition of Anxiety	1	0	6	7
Use of Humor	1	1	6	8
Individual Help	2	0	3	5
Availability	0	0	1	1
Small Steps	2	0	4	6
Activities to Aid Understanding	1	0	3	4
Motivational Activities	1	0	2	3
Opportunities for Success	2	0	3	5
Controlling Negative Conversants	0	0	0	0
Peer Discussions	2	0	2	4
Journal Writing	0	2	6	8
Math Autobiography	0	1	1	2
Other	1	1	7	9
Skill Building				
Support Materials	1	0	2	3
Examples of Student Work	0	0	0	0
Study Skills	1	2	5	8
Other	0	0	2	2

Table 7
Extent of Coverage of Outcomes

Element	Extent of Coverage			Total
	Little	Moderate	Comprehensive	
Achievement	0	0	3	3
Understanding/Use of Stats & Research	2	1	0	3
Attitudes	0	2	3	5
Avoidance	0	0	2	2
Other	0	1	0	1

"Conceptual models guide research by providing an outline of the phenomena to be investigated, the methods to be used to investigate these phenomena, how theories about these phenomena are to be tested, and how data are to be collected." (Fawcett, 1986, p. 85) Although the concept model for *EncStat* is not fully developed, a working prototype has been constructed, based on results of this study (Appendix B) that includes the six rules specified by Laudan (1981) and Schlotfeldt (1975):

- The nature of the problems to be studied and purposes to be fulfilled by the research
- The phenoeman to be studied
- The research techniques and tools to be used
- Settings in which data are to be gathered and subjects who are to provide the data
- Data analysis methods
- Nature of the contributions to advancement of knowledge.

As Strauss (1990, p. 42) notes "Theoretical sensitivity comes from a number of sources...", three of which are literature, professional experience, and personal experience. By analyzing and summarizing research about the phenomenon of statistical anxiety, the conceptual model which was begun in this study is expected to enhance the theoretical sensitivity of researchers and precipitate the formation of a learning community equipped with one common "language" to fulfill a common purpose. Further, it is hoped that the conceptual model will provide coherent direction for a comprehensive program of research related to statistics anxiety intervention.

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Appendix A
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Appendix B

Provisional Concept Map for EncStat, A Statistics Intervention Program
University of South Florida
February 2003

Nature of problems to be studied.

- Research interest in statistics anxiety has increased in recent years, as has emphasis on statistical literacy, but most of that attention has focused on undergraduate statistics students and little attention has focused on intervention.

Purposes to be fulfilled by the research.

- To explore how what is known about the causes and effects of statistics anxiety in undergraduate students applies to graduate students
- To incorporate current knowledge of statistics anxiety into a comprehensive, web-based treatment program
- To extend the research on statistics anxiety
- To collect data on the results of intervention efforts employed in *EncStat*

Phenomena to be studied

- Statistics anxiety (and other related anxieties)
- Negative attitudes toward statistics, which is subsumed in and presumed to be a causal agent in anxiety but which has been pursued in research efforts as conceptually distinct from statistics anxiety
- Application of traditional psychotherapeutic modalities to SA
- Skill deficit remediation techniques specific to statistics
- Classroom practice, knowledge of statistics anxiety, and personal characteristics of statistics instructors having particular impact on the anxious statistics student

Research techniques and tools to be used

- Surveys, paper/pencil and electronic, including modification of existing instruments (development and validation of instrumentation, as needed)
- Support materials, paper/pencil and web delivery of a multimedia program
- Focus groups, structured interviews (both professors and learners)
- Listserve discussions for statistics professors
- Controlled studies of treatment effectiveness

Settings in which data are to be gathered and subjects who are to provide the data

- Universities, colleges, and learning centers
- Primarily graduate students in education and the social sciences
- Professors and instructors

Data analysis methods

- Thematic analysis of text and narratives
- Meta-analysis of extant research base
- Descriptive analysis of prevalence
- Correlational and predictive analyses

Nature of the contributions to advancement of knowledge.

- Confirmatory extension of what is known about statistics anxiety in undergraduate students to graduate students
- Exploration, development, and refinement of intervention techniques
- Dissemination of information
- Development of collegial community for the study of statistics anxiety

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